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THE SPEED OF LIGHT

By Dr. Edwin E. Slosson.

Light is the swiftest thing in the world, speaking either practically, or theoretically. Practically, because we do not know of anything faster. Theoretically, because we cannot conceive of anything faster. For according to Einstein, a body gains in mass as it gains in speed. To push the smallest particle faster than light would require an infinite force and infinite forces do not exist outside of books.

The velocity of light through empty space seems to be one of the inexorable limitations of nature like absolute zero. It is a constant quantity that turns up in all sorts of calculations. It is not only the speed of the visible rays of light but also of the X-rays that are some ten thousand times shorter and of the radio rays that are more than a million million times longer. The flash of a firefly and the rays of the sun travel at this same velocity. It is the yard stick by which the starry heavens are measured, and molecular magnitudes as well. It gives us a fixed standard for time. Consequently it is important that its value should be known as exactly as possible.

But the reason given by Prof. A. A. Michelson of the University of Chicago for undertaking a new determination of this constant was different from any of these. When asked by a memeber of the U. S. Coast and Geodetic Survey why he was going to put in the summer repeating the experiments, since previous observers had already got remarkably close figures, he answered, "Because it is such good fun".

Then, seeing that this reply did not satisfy the interlocutor, he added another and more practical reason, that if the velocity of light were known to one part in 200,000, it would be possible to set up a flash light on one peak and a mirror on another as far away as could be seen, and so get the distance between them in two weeks as accurately as it can now be measured by the chain in two years. This method would also be of use in determining distances where direct measurements are impossible.

Timing the speed of light has been a hobby of Professor Michelson from boyhood. When he was a midshipman at Annapolis he set up a new form of apparatus with a range of 2,000 feet along the sea wall of the Naval Academy, and got better results than had been obtained before. Later he assisted Prof. Simon Newcomb in a series of determinations.

In 1923 he took up the work again in California on a longer range and with more delicate apparatus than ever, but the forest fires made the air too hazy.

But last summer he succeeded in getting excellent determinations which he has reported at the Centenary celebration of the Franklin Institute.

The method used is so simple that anyone can understant it, although the difficulty of carrying out a determination with such unapproached pracision can hardly by appreciated. It consisted essentially in sending a beam of light from one mountain peak to another at known distance, reflecting it back from a mirror there, and timing the round trip. The sending station was located on Mount Wilson, not far from the hundred-inch telescope, the largest in the world. The receiving and reflecting station was on the top of Mount San Antonio, 22 miles away. The distance was measured by the U. S. Coast and Geodetic Survey with an accuracy of two parts in a million.

The source of the ray was a powerful electric arc lamp giving a light almost as bright as the sun. Passing through a minute hole in fromt of the lamp the ray was caught on a revolving octagonal mirror, sent to Mount San Antonio, reflected back from there and received on the original mirror which is revolved at such a rate as to catch the returned ray on the succeeding face of the octagon. The mirror was rotated by a blast of air playing on a little windmill, and made 530 revolutions a second, its speed being regulated by a tuning fork of known pitch. The making of the mirror was one of the most delicate parts of the apparatus for if the angles of the octagon were not exact, the results would be erroneous. When this was completed and its angles tested, they were found to be equal with an uncertainty of only one part in a million.

In this simplified apparatus only two measurements are necessary: (1) the distance between the two stations which is known by direct measuremonts, and, (2) the time of the round trip, which is given by the speed of rotation of the mirror. The average results of eight observations gives the velocity of light in a vacuum as 186,300 miles per second. This cannot be wrong by more than twenty miles.

But Professor Michelson is not yet satisfied. He will try it again next summer and hopes to get it right within a mile by steadying the speed of the mirror. He thinks it possible that the distance may be extended to a hundred miles which would enable him to get the figure accurate to within one part of a million.

Let's hope, for other reasons as well, that there will be no forest fires in California next year.

NEW COMET DISCOVERED IN WESTERN SKY

A comet, which may never have been observed before, has been discovered at the Bonn, Germany, observatory by Professor Finsler. It is brighter than any comet that has appeared for several years and the reports received by the Harvard College Observatory, Cambridge, Mass., from the International Astronomical Bureau at Copenhagen, state that it is visible through strong field glasses, binoculars and small telescopes. Its astronomical magnitude is eight. This visitor to the solar system is sufficiently well developed to show a faint tail.

The discovery was made September 15. A second position was secured at Bonn Observatory two days later and the results were then sent to the observatory at Kiel, Germany,

which transmitted them to the International Bureau which distributes to observatories information about new astronomical discoveries. Professor Prager of Babelsberg Obervatory, about nine miles outside of Hamburg, Germany, then reported that he also had located the new heavenly object.

American astronomers were notified of the German observations at once.

Should the comet just discovered prove to be a new one and not a periodic object on another visit to the sun, it will probably be known as Finsler's comet since it is the custom to name comets after the astronomer who discovers them.

The comet just discovered may be Faye's comet discovered at the Paris Observatory in 1843. This is one of the well-known periodic comets which makes a round trip of its orbit every seven and a half years. The astronomical time tables show it is to be due close to the sun, about as far away as the planet Mars, this month But whether the object now in the heavens is a new arrival or an old friend of the astronomers will not be determined until an orbit is computed.

At least two observatories have located the new Finsler comet discovered at the Bonn, Germany, Observatory. Lick Observatory at Mount Hamilton, California, and the U. S. Naval Observatory at Washington have both determined its position.

On Tuesday evening, Sept. 23, the celestial visitor was located 14 degrees south and 2 degrees east of the reddish star Arcturus, and was found to be moving at the rate of a little over a degree a day both south and east receding from both earth and sun.

COMETS, GREAT AND SMALL

By Isabel M. Lewis,
of U.S. Naval Observatory

For more than twenty years astronomers have been anticipating the arrival of a great comet, worthy successor of the great comets of 1811, 1843, Donati's famous comet of 1858 and the great comets of 1880 and 1882 but so far they have looked in vain, for great comets, like great geniuses, are rare. Yet the present century has not been without its noteworthy and remarkable comets.

Chief among these were Halley's periodic comet, which returns every seventy-five years and which made its predicted return strictly on time in 1910, and the comet known as a1910 which was discovered in the southern hemisphere in the same year and which rivaled Halley's comet in brilliancy. Then there have been comets which were scarcely visible to the naked eye but which were of great interest telescopically, such as Morehouse's Comet of 1908 and Delavan's comet of 1913. Indeed the freakish and erratic behavior of Morehouse's comet surpassed that of any other known comet and its antics were observed with the keenest interest by the astronomical world because of the light that they might throw on the nature of comets in general.

Periodic comets such as Encke's comet, which has the shortest period of any known comet, three and a third years, and which was picked up this year at the Yerkes Observatory on July 31 by Prof. G. VanBiesbroeck, and Faye's and Tempel's comets due this fall, are continually returning to the vicinity of the sun.

Scarcely a year passes that several such comets are not picked up. Most of these periodic comets, however, are small, inconspicuous telescopic objects, often tailless, mere fuzzy patches, which are members of Jupiter's family of comets. For the huge planet plays the part of the spider to many a luckless comet fly, spreading out his gravitational web to catch any comet that chances to come within its reach. The captured comet subdued and harnessed is then forced to follow a path that extends little if any beyond the orbit of Jupiter. Frequent returns to the vicinity of the sun tends to disintegrate a comet and scatter its substance along its orbit in the form of clouds of meteoric particles.

The nucleus and head of a comet consists of a mass of meteoric particles of various sizes held together by their mutual attraction and surrounded by rare vapors and gaseous compounds, cyanogen, hydrogen and iron vapors frequently being present. As the comet draws near the sun light-pressure and electrical repulsion drive off from the head finely divided particles that go to form the tail. Such particles are permanently lost to the comet. They leave the head of the comet with accelerated motion and one tail is in turn discarded for another. So it is that the small periodic comets that have made many returns to the sun have little substance left to form the tails that are so characteristic of comets and look spent and faded compared to the great comets that frequently sport tails many million miles long and heads many thousand miles in diameter.

Comets great and small represent the fragments of the primitive mass from which the solar system was formed many million years ago. The great comets come fresh and unspent from the outlying regions of the solar system at intervals of thousands or even hundreds of thousands of years so it is little wonder that they shine at rare intervals with a splendor unknown to the small fry of the cometary world, Jupiter's captured family of periodic comets of which one or more members return to the sun practically every year.

PHILIPPINE FISH CLIMB OUT OF WATER

The climbing perch by no means is a figment of the imagination, according to Albert W. C. T. Herre, chief of the Philippine Division of Fisheries, who has just completed a classification of the fresh water fish of the Islands.

This fish, occurs in ponds, brooks and rivers throughout the territory. Not only does it climb trees but is able to move about freely on land and is remarkable for its ability to live for long periods out of the water.

Its actual climbing, however, is restricted to short distances - not more than two meters up the rough trunks of certain palms.

During the dry season the climbing perch is able to survive in very small pools of semi-liquid mud. During this time it takes the hook readily. Consequently it is not unusual to see natives fishing in what seems to be a dry field of waving grain. Out of a small mud patch in such a field from one to two dozen of these fish can be taken. It is claimed that the fish can survive for six days entirely out of water.

Mr. Herre describes another order of Philippine fresh water fishes which can be drowned in water. These are the labyrinthici, characterized especially by a large cavity in the head above the gills. Into this cavity the fish takes air directly from the surface of the water. The gills are unable to supply a sufficient quantity. If prevented from reaching the surface the fish eventually will

die. Popular superstition credits these creatures with the ability to live out of water, although Mr. Herre insists that if their gills become entirely dry they will die, just as other fishes.

Another species, the ophicephalidae, will drown if kept in water in such a position that they cannot reach the surface occasionally. These also endure prolonged removal from water.

The most popular of Philippine food fishes, the dalag, makes long voluntary journeys over land during periods of heavy rains. When the water of an inland puddle has evaporated the dalag is able to survive for along time by burrowing a foot or more below the surface to take advantage of the remaining moisture. Even after the surface of the mud has been caked over the fish will live as long as it is moist beneath. These fishes are sold alive in the native markets, being stunned with a club so that the customer can carry them easily.

STUDY COTTON CHEMISTRY; KEY TO WEEVIL CONTROL

Find what it is in the cotton plant that the boll weevil likes; produce it in marketable quantities; bait traps with it or mix it with poison, and so lure the insects to their destruction.

That is the skeleton of the idea on which scientists of the U. S. Department of Agriculture are working.

When the weevil comes out of its winter sleep, in the vicinity of a cotton-field, it somehow knows enough to make a bee-line for its natural home. It will sometimes travel considerable distances to reach growing cotton if there are no plants near at hand.

Dr. Frederick B. Power, the leading biochemist in the Bureau of Chemistry, with the cooperation of V. K. Chesnut of the same bureau, is endeavoring to find which of the many complex substances in the cotton plant gives it this peculiar attraction for the weevil and and this is a very difficult task. Large quantities of cotton plants have been subjected to steam and distillation processes, and the substances isolated tested for their power of attracting boll weevils.

This part of the work falls to the Bureau of Entomology, where workers watch the behavior of the insects toward the various substances.

Dr. Power states, with the characteristic caution of a thorough scientist, that he is "making progress", but will not make a direct claim that the problem has been solved. The results of the investigation will be announced to the scientific world and to the public in due time.

This new attack on the boll weevil problem may well become the pioneer work in a wholly new departure in the study of the relations between plants and the enemies that attack them. There are many other insects that show a similar preference in the choice of the plants they feed on. Potato beetles, for instance, confine their diet chiefly to potato plants; the Hessian fly commonly attacks nothing but two or three kinds of grain. In all such cases, there must be some definite attraction exerted by the plant, some specific substance that appeals to

the insect so strongly that it will turn from all other things to seek it. If such substances can be isolated and used as baits loaded with poison, or placed in insect traps, or set over pans of water or oil, or in other ways utilized to lure insect pests to their doom, another step will have been taken in the solution of the crop pest problem.

PROFESSIONAL AND BUSINESS MEN FATHERED 75 PER CENT OF TODAY'S LEADING AMERICANS

By Prof. S. S, Visher,
Indiana University.

Where have the notable people been born and in what kinds of homes? This question has been asked by many, and diverse answers have been given. Some persons have asserted that most famous Americans were born on a farm, as were Lincolm and Coolidge. On the other hand, certain studies of eminent people have revealed that many were born in cities and in the homes of professional people.

In order to throw light upon these questions, all persons whose biographical sketches appeared in the 1922-1923 edition of the "Who's Who in America"were asked to indicate both their type of birthplace and the chief occupation of their father, A study of the 18,400 returns received has recently been completed.

These returns indicate that 25.9 per cent. of the present day American notables were born on farms, 24.5 per cent. in villages and towns, 24.8 per cent. in small cities, 20.6 per cent. in large cities and 4.1 per cent in suburbs. In proportion to the population at the 1870 census, the census nearest the birth of most of the notables, cities contributed nearly six times as many as did farms, villages nine times as many and suburbs apparently about eleven times as many. The fathers of 70 per cent. of these persons belonged to the professional or business classes (34.3 and 35.3 per cent respectively*; 23.4 per cent. were farmers, 6.3 per cent. were skilled or semi-skilled laborers and only 0.4 per cent. were unskilled laborers. In proportion to population at the 1870 census, these classes ranked in the production of notables, in the order given, and had a value of about 1400, 600, 70, 30, and 1 respectively. In other words, farmers fathered slightly fewer notables than their proportionate share, but they did much better than other manual workers, contributing 2 1/3 times as many as skilled and semi-skilled laborers and 70 times as many as the nearly one half or all of the men of the nation who were classed as unskilled laborers. Business and professional men fathered 7 and 16 times, respectively, the number of notables that would be expected on the basis of the small proportion they made of the population. Clergymen did exceptionally well, according to these returns, having fathered fully 28 times their proportional share of notables, or over 2400 times as many as the average unskilled laborer.

There are two radically different possible interpretations of these data. Certain eminent biologists, including Galton and Davenport, believe that heredity is of prime importance and hence that the nation's notable men come from the intellectually superior elements of the population, which are concentrated in certain types of occupations and places. On the other hand, Ward, Cattell, and others believe that environment is the chief factor, and if given a proper chance, many people who never become eminent, could rise so far above the average as to merit inclusion in such a standard work as Who's Who in America.

This study does not indicat whether "nature" (environment) or "nurture"

(heredity) is the more important, nor does it accurately describe conditions today when the leaders of the fifty years hence are being born. It does, however, clearly indicate that a large share of the present notables came from certain relatively minor elements of the population, more than 1/3 from the professional classes which comprised only 1/45 of the population in 1870. The five per cent. of the men of America classed as business men contributed 35 per cent. In contrast, unskilled laborers fathered almost none of the notables in Who's Who, and although farmers fathered nearly one fourth that proportion, that is, slightly less than their share in proportion to population.

CHEMIST AT LAST ANSWERING "WHAT IS WOOD?"

Cellulose, whose chemical structure has baffled chemists for a century, is yielding to the searching eye of the X-ray spectrograph in the hands of Dr. O. L. Sponsler, botanist in the University of California, Southern Branch. The most recent photographs lead to the belief that cellulose - a stick of wood for example- consists of a multitude of strings of molecular beads all running parallel.

Many years ago chemists discovered that cellulose consists of carbon, hydrogen and oxygen in the proportion of six, ten and five atoms respectively. Little more is known of its chemical architecture. Cellulose does not crystallize, vaporize, melt or do any other orthodox act which would help out the analytical chemist. In the light of X-rays, however, it now yields a series of remarkable line photographs which indicate the bead-string style of structure.

The "beads" are all alike. Each apparently consists of a cluster of the twenty-one atoms above mentioned firmly combined like an individual chemical molecule, but still chemically tied to its two neighbors in the string, above and below. It requires about fifty million of these, end to end, to span the distance of one inch. Ordinary light waves are too coarse to reveal such minute details, so that there is no hope of visibility even in a powerful microscope. The minute X-rays, however, are able to pick out and exhibit such atomic details to the camera.

Dr. Sponsler pictures the cellulose units acting as beads closely strung on a tight cord. The chain resists a pull better than a push. This agrees nicely with the well known principle that a timber will withstand a greater tensile strain than a crushing strain.

The bead chains, being separate, can easily spread apart without breaking. This also agrees with the familiar fact that a timber, soaked in water, will swell sidewise but not lengthwise.

The new theory tells us that a broken strand of cellulose should have reactive atoms at the ends of the chains, where the rupture occurred, and where there is obviously no material to hand onto the last link. This agrees with the known fact that certain chemical tests work on the end of a fiber, but do not succeed on the side.

When the cellulose fibers are photographed endwise, only a few simple lines appear on the plate, and the bead-chain structure is missed. Viewed from the side, however, the strings are revealed.

TELEPHONE AND PHONOGRAPH COMBINED AGAINST CRIME

The post-war wave of crime has been as much of a problem in German as in American cities. To combat it, a special telephone device has been installed. Whenever any one is in need of the police, he calls Central, says "Emergency call", and gives his address. A motorcycle or auto patrol starts at once.

The newest development involves the use of a phonograph with a record of the police call phrase. This is connected electrically to doors and windows, so that if a marauder forces an entrance, an arrangement of levers takes down the receiver, the phonograph, simultaneously started, repeats the call into the telephone, and keeps repeating it until stopped by the operator at Central.

DYING EXPLORER LEAVES RECORDS

The last records of an explorer lost in the desert in Africa forty-five years ago have just been discovered. In 1879 Friedrich Rolfe, undertook to cross the Lybian desert, one of the most barren and pitiless wastes in the world. He never was heard of again.

This year an expedition sent out by Prince Kamal ed Din found a cairn of stones, and when they took it apart discovered within it a sealed bottle containing a manuscript. The latter proved to be the records of the lost explorer. These were forwarded to Germany, and were found to contain scientific data of considerable interest and value.

GERMAN PHYSICIANS X-RAY BLOOD VESSELS

A new field of usefulness has been opened for the X-ray in the discovery of a method for taking pictures of arteries and veins, by two German scientists, Drs. Isidor Berberich and Samuel Hirsch of Frankfort.

The method consists in injecting into the blood vessels a substance which is opaque to the rays, and which will permit shadowgraphs of the arteries and veins filled with it to be taken, just as shadowgraphs are now taken of bones and metal objects, and of the digestive organs when the latter have been filled with a "bismuth meal", which is also opaque to the rays.

The compound used for X-ray photographs of blood vessels is strontium bromide, which can be injected into the blood stream without harm. It is curious to note that strontium bromide has been used in medicine for many years, without any one discovering its value in X-ray work.

In order to determine suitability of foreign trees for introduction into this country, arboretums in which groups of such "immigrant" species can be tried out are being established in several of the National Forests.

FOREST FIRE PUT OUT BY FOG

A heavy dripping fog rolled in from the Pacific ocean and put out effectively a fierce forest fire which had been burning for days in the Olympic peninsula southwest of Port Angeles, Washington. This is the only time recorded in northwest forestry of the occurrence of such a phenomenon. With no indication of rain and lacking water with which to fight the advance of the flaming menace, foresters watched the fire making progress toward the town of Quilcene, beyond which lay valuable tracts of big trees, when suddenly the wet fog descended. Like a huge grey cloud it settled down upon the forest enshrouding everything. The fire fighters fled in terror lest they become bewildered and lost on the mountian sides. Soon the pungent smell of cedar and hemlock smoke disappeared and by mid-afternoon when the fog lifted there remained but a few smoking dead logs while all about the charred trunks of former merchantable trees dripped with water from the providential fire extinguisher.

PREHISTORIC ANIMALS TROD DENVER SIDEWALKS

The flagstone sidewalks of Denver and other Colorado cities were once walked by animals that throve on earth long before man, before the wooly rhinoceros and the saber-toothed tiger, and ages before even the dinosaurs appeared. This is the explanation given by Prof. Junius Henderson, of the University of Colorado geology department, for the peculiar track-markings in the sandstone that was quarried and made into the older walks of the city.

These animals, he says, were not large, only about the size of a Gila monster, though they were not lizards but amphibians like the modern salamanders and newts. They walked high on their toes, for there is no sign that their bodies trailed in the soft sand that later was hardened into stone. If they had any tails they carried them high also, for there are no markes of dragging tails. And they were a sober, well-behaved race, for the tracks do not zig-zag, but proceed in orderly, straight lines.

EARLY STONE AGE HAD ALPHABET OF PEBBLES

Did stone age men begin to learn how to write fifty or a hundred thousand years ago? Prof. William Paulcke, student of the ways of the ancient cave dwellers, thinks it possible.

As support for his theory he points out the steady change in early stone age art, from the realistic to the conventional. The cave paintings of the earliest peoples, he shows, were much better pictures, looked at purely an art, than were the later ones. There was a steady tendency through the early ages to formalize art, until at last the figures became simply conventional symbols and were no longer pictures at all.

Toward the close of the Old Stone Age they painted mysterious signs on pebbles, which have been found in the upper strata. They may have been merely playthings; but Prof. Paulcke points out that the present-day Australian aborigines have similar painted stones and sticks. The figures on these ancient pebbles are strikingly like the picture-writings of the Chinese, Babylonians, Egyptians and Mayas.

"AVERAGE CITIZEN" USES SEVEN GRAINS OPIUM YEARLY

Opium and cocaine, aside from a large but unknown illicit consumption, have a recognized and legal medical use to the extent of 6.98 grains of pure opium and 29.32 grains of coca leaves per capita per year. These figures are based on the investigation of A. G. DuMez, pharmacologist in the service of the U. S. Public Health Service.

Mr. DuMez got his figures not from a general survey of the country as a whole, but from a close study of a good "sample" of the population. He chose Allegany county in Maryland partly because it contained no large cities with their abnormal conditions, and partly because it was a region of diversified population following several industries. He investigated the permitted use and traffic in drugs in pharmacies, doctors' offices and hospitals.

All drugs containing opium, such as codeine, morphine, and paregoric, he reduced to terms of pure opium. Similarly, he reduced cocaine to terms of the coca leaves, the form in which it is imported. He found that the legitimate medicinal needs of the county called for an annual importation of 69.81 pounds of opium and 293.03 pounds of coca leaves. Divided among the 69,958 persons in the county, this allowed 6.98 grains of opium and 29.32 grains of coca leaves as the yearly ration per person.

To supply the entire United States on this basis, would require the annual importation of approximately 105,587 pounds of opium and 443,988 pounds of coca leaves. Mr. DuMez is of the opinion that the lawful requirement for cocaine is falling off, because of the increasing use of synthetic local anesthetics by dentists.

TWELVE NEW PLANT DISEASES REPORTED IN UNITED STATES

Twelve new bacterial and fungous diseases of plants have been reported as existing in the United States by the Plant Disease Survey of the U. S. Department of Agriculture. Some of them are diseases previously known from other countries, and the others are now described for the first time. The crops afflicted are corn, barley, sorghum, broomcorn, clover, cowpeas, soy beans, and a number of grasses.

It addition to the new diseases, several pests previously known in this country have appeared in localities hitherto unvisited. Flag smut, a very destructive wheat disease reported from Illinois and Missouri, has crossed into Kansas. "Take-all", another wheat disease, has appeared in North Carolina, Tennessee and California, and in California is afflicting barley as well as wheat. Root rot of clover and alfalfa appears to be spreading into new areas, and leaf-mosaic diseases have made new inroads among grain and hay crop plants.

A recent German invention opens the shutter of a camera and fires a flash at the same time.

Relatively little damage was done in the South during 1924 by the cotton boll weevil.